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ABSTRACT

Dangers are inherent in predicting the future. In discussing the future of computers, specifically, it is useful to consider the brief history of computers from the development of ENIAC to microcomputers. Advances in computer technology can be seen by looking at changes in individual components, including internal and external memory, the keyboard, and screen. As long as breakthroughs and advances can be made in very large scale and ultra-large scale integrated circuitry, the cost per computing unit will continue to go down and size/weight per computing unit will also decrease. A flat screen will provide a major breakthrough to the lapsized, full-function computer. The future of personal and educational computing can also be viewed by analyzing computer applications, including computer science, computer assisted instruction, and computer managed instruction, as well as the more interesting uses of the computer as an interface to the growing world of information and as a general problem solving tool. Colleges should create full-time positions for faculty members solely to keep up with the growth of technology and information as it applies to the higher education profession. Nine references are listed. (LMM)

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MICROCOMPUTERS AND THE FUTURE

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Alabama State Computer Fair: 12 May 19
Birmingham, Alabama

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On the Prediction of the Future:

There is an inherent danger in being billed as a "futurist". That danger is that someone may remember what you predict and come back to remind you of it. To show you how wrong a prediction can be, let me read you the following prediction.

"Technological evolution is still accelerating. Technologies are always constructive and beneficial, directly or indirectly. . .Consequently, a few decades hence energy may be free--just as unmetered air--with coal and oil used mainly as raw materials for organic chemical synthesis, to which, as experience has shown, their properties are best suited."

Now, that was not written by Jeanne Dixon or spoken by Carnac the Magnificient. It is a written quote from John Von Neumann in 1955. Von Neuman you may recall contributed greatly to the Mathematical and Numerical Integrator and Calculator (the acronym for which is MANIAC) which was vital to the development of the H-Bomb. In an unpublished and unrevised paper in 1945, entitled "First Draft of a Report on the Edvac" Von Neumann set forth the concept of the stored program which allows program instructions to tell the computer what to do with a set of data. We take that capability for granted today but, in 1945, it was considered revolutionary.

I bring forth that 1955 quote simply to emphasize the dangers inherent in making futuristic predictions. You have heard of IBM, of course. When IBM made its first market forecast

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for computers in 1948 it decided that the market was too small to make market investment profitable. By way of prefatory remarks about the future of computers, it is useful to remember several of the highlights of the brief history of the field.

History:

I remember a friend of mine in high school who immensely disliked the study of history. First, he said, there is too much of it. Second, it keeps getting bigger. He probably would not have liked the history of computing either, although there is not so much of it, it is getting bigger and bigger.

In 1944 There was no computer. At least none in the operational sense. There were theories and there were designs. And there were scientists working.

In 1946 we had the ENIAC. A 30 ton monster: The story goes that the lights dimmed in Philadelphia when the ENIAC was turned on. Three weeks ago I bought my fourth computer: a KayPro II which weights about 26 pounds and cost about $1200.00 Among other things, the KayPro will add and subtract faster than the ENIAC.

In 1964 at the U of Wisconsin-Milwaukee here is how the computer system worked. We would keypunch control cards and data cards on an IBM card punch. These would be delivered, physically, to a central location where, everyday about 5 pm they were entrusted to a workstudy student who would drive them, physically, 90 miles to the main campus at Madison, where, overnight, they were processed. The next morning another workstudy driver would return them to Milwaukee by 9 am. If

the driver got to Madison--not always a guarantee particularly in the snowy, icy winters--and if the computer was UP, and if there were no fatal errors in the control cards, you were provided with less than 24 hour turn around time--a highly efficient response in those days.

In 1964, if you had a million and a half dollars, a federal clearance, highly skilled technicans, a large secure room with air and humidity control, etc. you could get in line to purchase a computer.

Ten years later, in 1974 there was no microcomputer on market but the seeds of the microcomputer was germinating. The Home Brew Club in California--where Wosniak and Jobs got there start--was meeting and experimenting with the new silicon chips. Now ten years later, in 1984 there will be more micros produced this year than in the history of the world up to 1983.

International Data Services projects that there will be 59 million personal computers sold and installed by 1989. That averages out to approximately one per household. A survey reported just this past week in USA Today (Thursday, May 10, 1984) relates that 15 percent of us have a home computer and 20 percent plan to either buy one for the first time or upgrade present equipment. Moreover, according to this survey, 45% of Americans use one at work, and that 3 million households have purchased a computer already this year, which is a pace which is 33% ahead of last year.

What can we expect in the future. A computer consists for various components: these include a central processing unit,

internal memory, external storage, a visual display of some kind, and an input device. Let's look at these individually.

First, lets look at internal memory. The 256K bit chip is now commercially available. IBM recently announced a chip which has one million bits per chip. The Japanese have had the megabit chip operational for several years and state that they have the working drawing for a sixteen megabit chip which they hope to produce in five years. And they are discussing the feasibility of a one billion bit chip. Think for the moment about the difference between one million and one billion.!!!! I'll give a quasi-sexist analogy which the men in the audience will certainly understand. If your wife comes in and asks for some money to go shopping, and you give her one million dollars and tell to spend $1000 per day, she will be back in less than three years. If on the other hand you give her one billion dollars and tell her to spend at the rate of $1000 per day, you won't see her for over three thousand years. (See Note #1)

So long as breakthroughs and advances can be made in very large scale and ultra large scale integrated circuitry the cost per computing unit will continue to go down, and size/weight per computing unit will also decrease. How small will depend on user convenience or inconvenience. Consider the key board and screen.

Note 1. On May 1, 1984 USA Today reported a portion of a conversation with Keiske Yawata, president of NEC Electronics USA, who responded specifically to the question of the feasibility of a 1-billion bit chip. "It may sound unrealistic, but so did 1 million," Yawata said. (Techtalk. P. 3B)

I have a Brother EP-20 which is more accurately discribed asa battery-powered, lap-sized electronic note pad and calculator. It has a 16 character liquid display. I have not encountered an air line which would not permit to use it in flight. I prefer it to pen and yellow pad; it takes up little space; but I would never use it as a regular alternative to either of my luggable computers. I am addicted, or at least permanently accoustomed to the feel of a standard keyboard. The chicklet type and laminated keyboards hold little interest to me as I suspect they hold little interest to most accomplished touch typists. A standard keyboard requires a specific amount of area, and probably sets one of the more permanent parameters of computer size. Currently, the other two parameters are set by the viewing screen and the external memory. External memory has come from 8 inch floppies, to 5 and 1/4 inch floppies, to a series of rigidly encased 3, 3 1/4 and 3 1/2 floppies each of which, in turn, has reduced size and weight requirements of a really portable micro.

In this regard, industry watching can be fascinating. For example, it was reported several weeks ago that the IBM plant in Boca Raton which produces the Personal Computer placed an order with a Japanese firm for one and one-half million optical videodiscs. Some of you may have seen our demonstration of the laser optical video disc player and recall that one side of a laser disc--the twelve inch size--will hold 54,000 frames of information. Each frame contains the potential for holding tens of thousands microscopic, laser induced bits of digitized information in a read-only format. Now what would the IBM PC

division want with 1.5 million laser videodiscs? The most plausible answer is that they will use them as read only hard disks for future personal computers. The 6 or 8 inch discs which they have on order have sufficient space to easily include all of the important commercial software currently available in PC-DOS, the operating system for the IBM PC. Once a master disc is made it can be reproduced at about $5.00 per side, or $7.50 if both sides are used. With appropriate agreements with software producers, IBM could package the most incredible software bundle anyone ever imagined, in a format which is durable, extremely fast, and very hard to pirate. Such a package on the IBM operating system might literally blow some competitors out of the water. It is too bad that with all of their resources and experience, IBM cannot make a reasonable keyboard for the PC. (See Note #2)

More importantly to many users is the size of the screen, and the CRT has dictated much of the size and weight requirements. A flat screen will provide a major breakthrough to the lapsized, full function computer. SAI Technology introduced GRIDSET for use by the military in late April. Hewlett-Packard introduced Nomad this past week. Apple is scheduled to introduce a flat screen for the Apple IIc this fall. All are lap sized, notebook sized full function computers which have screen technologies

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Note 2. If you noticed the use of disc and disk, it is not a typographical error or a lack on the author's part of consistency. Hard and floppy peripherals are called disks. But the video field has consistently spelled the term disc, as in videodisc. It may be that when videodiscs are adapted to computers external memories they will be called videodisks, or perhaps videodiscks.

based on anything from liquid crystals (like your digital watch) to electrophoretics--magnetic particles which rise to the surface of the screen, to a flat cathode ray tube. And Alan Kay who was chief scientist for Atari is interested in producing Dynabook--a notebook size computer which has its keyboard drawn on a touch sensitive screen. It was announced last week that Kay has agreed to go to work for Apple as Apple Fellow where he will pursue independent research on user-interface subjects such as artificial intelligence and communication between computers and people. I would not be surprised to see Dynabook emerge from these efforts.

Of course, there are other ways to communicate with a computer other than via the keyboard. One is touch screen graphics. A second is a plastic stylus applied to a pressure-sensitive graphics tablet. You can point with a mouse, such as on the Apple MacIntosh, or you can write with a light pen. It is possible to program with a joystick, and with a voice activating system, the computer will record the voice and transforms it in into a digital pattern of ones and zeros. Currently, this latter system as it is now commercially available can recognize upto 50 commands--usually these are programming commands such as PRINT, GO TO, IF THEN, NEW, HOME, and the like. All of these input modes have specific uses--voice activation for certain physically handicapped users, for example--and all have limitations particularly with regard to data and text entry. But the technologies point the way to what we can expect in the future.

When we standardize, if we standardize, a number of

competitors will be driven out of business and costs are apt to level out. Consider the situation if the only personal computer were the IBM. Frankly, I oppose premature standarization. The inconvenience I have in not being able to put Apple IIe disks in my Osborne or KayPro is outweighed heavily by the new products on the market which, I do not believe, would have been on the market if we had standardized two years ago.

A useful way to consider the future of personal and educational computing is to analyze the uses to which computers can be put, particularly in educational and home settings. There are five general uses which have been identified. These include:

1. A tool for computer science where they are used for students who want to learning programming, repair and maintenance, computer architecture and the like.
2. A second use is the traditional CAI mode, where the computer supplements or complements instruction through drill and practice, tutorials, simulations, and related activities.
3. A third use will be in CMI--Computer Managed Instruction where the computer assists the teacher and administration in activities such as student tracking, test scoring, information storage and the like.

These first three are really very traditional, and not nearly as interesting as the final two on the list. The latter two include using the computer as an interface to the growing world of information and using the computer as a general problem solving tool. I would like to dwell on these two at some length.

Is necessity the mother of invention, or invention the mother of necessity? We have computer science emerging in our

secondary schools because of the invention and general acceptance of the microcomputer; the microcomputer was not invented because educators felt a need to integrate computer science into the secondary curriculum. And while computers were in existence for over 30 years before the invention of the microcomputer, in schools if they were discussed at all it was more as a curiousity except, perhaps in business education where data and word processing might have been covered.

We can invoke the analogy of the automobile again. I would guess that most teachers in Alabama can drive, and often drive to work, and would whether or not driver education was offered in Alabama schools. Now, there may be some excellent reasons to offer driver education--but do not confuse necessity with desirability. I think we will find the same is true of computer literacy. Within a few years the debate about the necessity of computer literacy, as a formal course at least, in the schools, will have died out. There will be computer science courses because it is desireable that some individuals be formally trained on the history, architecture, programming, of the computer. But, I would guess that within 7 to ten years the vast majority of students and teachers will be using the microcomputer as a tool to achieve learning and teaching objectives. Routinely, as they use an automobile today whether or not they had driver education. Or, more relevantly, as they now use a pencil and paper.

Let's look at the MacIntosh. Adam Osborne thinks that the Mac will be a failure. Some people at Apple think that the Mac

will be so successful that it will substantially cut into sales of other Apple products as the III, Lisa, and IIe. My view is that they are both wrong. Individuals who like the programs available for the 6502 chip will continue to purchase from the II family. Individuals who like traditional keyboard entry protocols will stay with the Lisa, or III if they have it now, or will stay with a computer that offers a good wordprocessor, such as WordStar and has integrated software, such as LOTUS 1-2-3. What the Mac is apt to do is to carve out a whole new group of users, middle and upper managers, for example, or creative consultants, who do not view keyboarding skills as a relevant managerial activity, but who doodle and sketch their way through a dozen yellow pads each month. My guess is that this is a substantial potential market share and the MacIntosh is an ideal system for them. I think that most people I know who have computers use them as a general purpose tool: writing this report, sending that information, balancing this budget, projecting that deficit, even finding some entertainment or diversion using a game. Learning to use the microcomputer is such a way is probably as important as using a pencil--perhaps even more important. (See Note #3)

Will computer usage deter from the traditional basics???

Note 3. Incidentally, what might be the most important contribution of the MacIntosh is neither the mouse or the chip technology. It is that fact that Apple is producing MacIntoshes at the rate of one every 27 seconds, and that only 1 percent of the cost of the machine is labor. Now, that is impressive, particularly when you realize that when you buy a $12,000 automobile, nearly 50% of that cost goes to labor. By the way, I heard, but have not been able to verify, that the IIc is being produced at a rate of one every seven seconds.

Take reading for example. Anyone who suggests that the computer will inhibit reading skills has never tried to read one of the technical manuals which comes with most hardware and software. I think, if anything, the microcomputer will provide additional motivation and experience in reading. Reading, the understanding of arithmetic operations, writing with clarity: the needs for these skills are going to increase as technology increases. Happily, it seems likely that the increase in technology will not only add to the need for these skills but that technology will provide a vehicle to increase this skills. Take creative writing and the use of electronic word processing. Bank Street School in New York City teaching 4th, 5th, and 6th graders to write all their assignments using Bank Street Writer. The preliminary evidence is that students write more, writer better, and enjoy writing more as a result. The key to creative writing is revision; not recopying. For a number of years I taught a graduate course in applied educational statistics. I was never pleased with the result. If I spent the time required to have students carry out the various computations by hand, or with hand held or mechanical calculators, we spent so much time looking for arithmetic errors that there was very little time to think through the other important elements: interpretation of the resultant statistic; violation of basic assumptions--for example, what happens to a coefficient of correlation if one of the variables is highly skewed; how distributions might change as a result of extreme outliers. etc. Also the hand-based calculations almost always required such small data sets that

examples were in no way related to reality. When the mainframe system and the canned packages such as STATJOB, SPSS, and the UCLA BioMed series became available we went through a time where we used large, reallife data sets and emphasized interpreation heavily, but students had no expereince with controlling the data analysis. I think that the electronic spread-sheets which are available today can be used to achieve most objectives in a applied statistics course. The student retains control over the data. The student must know the arithmetic operations which are required by the statistical program--not only the formula but the order in which operations are performed. The student can easily add or delete extreme scores to see, visually, the impact that outlying scores have on a distribution. In fact, with some of the advanced applications such as SuperCalc3 and Lotus 1-2-3 the distributions can be visually presented. Moreover, if we want large number of students to think in research terms, and to test hypothesis about reality based on numeric data, the ability to use a general purpose program on a personal computer makes a lot more sense than tieing them to the demands, costs and restraints of a large mainframe housed at some institution.

Probably more important than computer literacy is informational literacy.

One of the most exiting developments from my point of view is what is happening with the information explosion. There are some interesting projections available. For example, from the time of the invention of the printing press it took nearly 200 years for the amount of information in the world to double. That is, from the beginning of recorded history until about 1450

constitutes baseline data, and by 1650 that amount of information doubled. In 100 years, by 1750, it doubled again. That amount doubled again by 1800, and for about 100 year information doubled about every 50 years. During the first part of this century information doubled every 20 years, and the projection now is that information will double every 5 years until the end of the century. When you have a base which double itself, then that amount doubles, and so forth, you have an exponential curve. Many people have trouble understanding the nature of exponential curves because so much of what we do is linear. Let me give you two examples which if you have not heard before you may find fascinating or terrifying.

When I was a boy in a small rural town in Nebraska I had never hear of exponential curves. But we had a game we would play on a favorite uncle or the town drunk when we could. We would say, "Uncle Ed, I will work for you for a penny a day, if you will double my pay every day. I will work for a month. OK??" Of course we never collected but it is interesting to note that if you start at a penny a day, and double your pay every day, by about the 18th day you are making a million dollars per day !!!!

An every more impressive analogy is what happens if you were able to take a piece of paper, fold it in half, fold it again, and continue the process 50 times. How thick would the piece of paper be???? Again, the impact of this phenomenon is increased if you work out the arithmetic yourself. It is easy to do on a hand held calculator until you screen fills up. If you guessed a

thickness of a few feet you are probably about average, and if you guessed, perhaps, a mile you are better than most college students of whom I have asked the question. If you guessed that the paper would be thick enough to reach out beyond the moon and out toward the Milky Way you can congratulate yourself on having a good grasp of exponential curves. (See Note #4)

Erasmas was the last living human being credited with have accumulated, personally, all of the available knowledge in the world. It is not a coincidence that his term ran out in the same half century that the printing press was introduced. And information is doubling every five years. The successful citizen, and the successful nation, will be those who are able to access, process, interpret, and apply this vast body of knowledge. The old methods will no longer suffice. Think of the existing method.

Information is Produced.

Information is Printed.

Information is Distributed.

Information is Sold or Used.

The difficulty with this model is that the relationship between what is printed and what is sold/used is never perfect. In 99 % of the cases, too many or two few copies are printed. Second, the printing process often takes an inordinate amount of time.

Note 4. When I last computed the more or less exact thickness, using as a base point the thickness of a sheet of paper as .0043 inch, I obtained the following estimates. After ten folds, the paper is approximately 14.4 inches thick. After 20 it is approximately 370 feet thick. After 30 times, it will be 72 miles thick. After 40 times it will be 74,000 miles thick, and after 50 it will be, approximately, 36 million miles thick.

As a consequence, by the time the information is distributed, it is often out of date. The modern technologies offer a more responsive model.

Information is produced.

Information is distributed.

Information is sold/used.

Information is printed.

(See Note #5)

The difference between this model and the first is that in the latter, only the amount of information in demand is printed, and distribution takes place electronically. The result is information which is less expensive, more timely, and more relevant. There are, according to the 1983 Encyclopedia of Inforcmation Systems and Services over 2500 machine readable data bases in existence, ranging from the Arts and Humanities Citation Index to the Zoology Journal.

And how might this all work. Robert A. Block, President of the Telease Corporation, describes it as follows.

In a few years, small antennas on rooftops across the United States will provide access to hundres of millions of pages of information every day. When we consider technology trends, the growing need to access an expanding volume of information, and the efficiency of electronic distribution of information versus hard-copy distribution, the establishment of a satellite-based

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Note 5: I am endebted to Robert Block, President of Telease, Incorporated, for calling to my attention the differences between the traditional and electronic models of information dissemination. I have also drawn liberally from his remarks and writings concerning the feasibility of a world information

utility.

information utility appears to be the natural next step. Such a utillity could be launched by the U.S. within a few years and could be expanded worldwide by the end of the decade. The amount of information that could be delivered by high-powered satellites to two to four foot receiving antennas is virtually unlimited. The equipment necessary to receive, decode, and display text, slides, sound, and full-color motion will cost less than $500. Most of the elements necessary to launch the information utility in the U. S. already exist in one form or antoher. They are to be found in satellite communication systems, telephone-based data networks, teletext, videotext systems, pay television networks, teleconferencing and interactive media networks, personal computers, vido tape records, videogame technology, secure encryption, and electronic billing systems. The establishment of such an information utility in this country is likely to occur within the next few years. There are no technical, regulatory, political or economic roadblocks to such a service. There are some non-technical problems far more complex than the technical ones. Issues such as cultural, religious, and political censorship, cross-boarder data flow, language, copyright and patent protection and the like will need to be addressed in one form or another. (See Note #6.)

Note #6. InfoWorld, Volume 6, #21, May 21, 1984 includes two particularly relevant articles on this subject. "Videotex Changes Direction" (Jim Bartimo, Pp 34-35) and "Databases Target Micro Users (Doran Howitt, Pp 36-39) describe some of the activities which are currently on line concerning this phenomenon.

Consider, for example, the plight of the Soviet Union. A society such as Russia requires strict control of information flow. That is one of the reasons--the primary reason, actually--why the Soviet Union pays so much attention to censoring internal publications and jamming outside communications. On the other hand, the Soviets are very concerned about the inabilities their engineers have had in producing anything remotely as sophisiticated as the integrated circuitry which countries like the U.S. and Japan regularly introduce. One problem in Russia is that, by and large, the students do not have access to modern computers. Currently, in Russia, computer science students attend colleges and universities without paying any tuition--it is all funded by the state. They spend five years of full time study and log over five hundred clock hours of lectures, labs, and practice as well as about fifty hours per year of independent research. And what do they practice on? The best line of homegrown computers in Russia are the RYAD series, which is virtually a circuit by circuit duplicate of the IBM 360 model which is 20 years out of date.

One of the problems the Soviets face is permitting what we might call hackers or hobbiests have access to microcomputer and microprocessor technology. They cannot allow citizens to have open, virtually unlimited access to information and still hope to maintain a totalitarian regime. Recently, much has been written about the difficulties the East Germans have had with West Berlin Television broadcasts. An information utility as described above

particularly in under developed or highly controlled countries is going to make a number of people very nervous. It seems to me however, that this information utility is inevitable.

On a smaller scale, much of this is available now on Telenet, Tymnet, and Uninet trunk lines through such systems as The Source, CompuServe, Delphi and others. BRS AFTER DARK provides inexpensive title, author and abstract searches in the home for individuals now. Up to now, most databases available have been bibliographic conraining abstracts or summaries of the material. Modern technology allows the user to search through huge data bases in minutes and save, using appropriate communication software and a microcomputer, those sections of interest. You can now access the Philadephia Inquirer, the Miami Herald, and the Washington Post through Vu/Text Information Services of Philadelphia, and another group, Information Access Company of Belmont, California, is negotiating with Time, Inc, to add its seven magazines to their data base which now carries the full text of over 130 journals.

According to the USA Today survey quoted earlier, one of the major uses respondents had for the computers they were purchasing was to access online encyclopedias, such as Academic American which is available through CompuServe. Have you priced an full sized, top of the line, up to date, encyclopdia recently? For what the Brittanica costs you can obtain many hours on CompuServe and other data bases which are updated regularly.

During the eight years I have been Dean of the College of Education at the University of South Alabama I have been trying to determine what the impact will be of the new technologies on

education at all levels. I do not know the answer to that, but if there are any University trustees or presidents, or school board members, or superintendents of schools in the audience I have a very serious suggestion. The field is changing too rapidly to leave decisions concerning technology and information to a fast talking salesman or a staff member who can devote only part time to understanding what developments are occuring. Just keeping up with the field is a full time position for even the most dedicated student. If I were a college or university President today, I would insist that every Dean identify one faculty member who had the full time assignment of keepling up with the growth of technology and information as it applies to the profession. Then I would allocate a line item; perhaps $40,000 per year to cover travel, subscriptions, references, hardware and software for each position. In Arts and Sciences, I might insist on two faculty, one for the sciences and mathematics, one for the arts and humanities. The faculty assignment would include curriculum development and faculty development.

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